Turning Chutes into Ladders for Women Faculty: A Review and Roadmap for Equity in Academia

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Abstract

Despite significant progress in recent decades, the recruitment, advancement, and promotion of women in academia remain low. Women represent a large portion of the talent pool in academia, and receive >50% of all PhDs, but this has not yet translated into sustained representation in faculty and leadership positions. Research indicates that women encounter numerous ''chutes'' that remove them from academia or provide setbacks to promotion at all stages of their careers. These include the perception that women are less competent and their outputs of lesser quality, implicit bias in teaching evaluations and grant funding decisions, and lower citation rates. This review aims to (1) synthesize the ''chutes'' that impede the careers of women faculty, and (2) provide feasible recommendations, or ''ladders'' for addressing these issues at all career levels. Enacting policies that function as ''ladders'' rather than ''chutes'' for academic women is essential to even the playing field, achieve gender equity, and foster economic, societal, and cultural benefits of academia.

Keywords: gender equity, pay gap, implicit bias

Introduction

IN THE UNITED STATES,[1] women constitute half of those earning PhDs[2] and, as of 2015, 51.5% of assistant professors; however, women are generally less likely to achieve tenure than men and constitute only 32.4% of full professors.[3] Despite progress, women remain under-represented in academia at the highest levels, particularly in science, technology, engineering, mathematics, and medicine (STEMM).[3–13] This disparity is even greater among under-represented racial/ethnic groups such as black and Hispanic women who comprise ≤5% of tenured faculty in the United States.[3] These statistics only scratch the surface of data documenting the higher rates at which women leave academia (*i.e.*, the ''leaky pipeline''[13–15]) and are prevented from rising in rank[13,16] relative to men.[3] While women leaving academia represent significant economic loss from years of investment in training, the cost of women not being promoted to high-level positions may be equally significant. Gender diversity among leadership has been positively correlated with profits, productivity, and creativity,[17,18] thus earnings and prestige of academic institutions are likely compromised by the continued under-representation of women in high-level positions. More holistically, gender inequity in academic leadership results in educators not representative of our current and future society,[19] undermining the ability of academic institutions to create the inclusive learning environments and diversity in educational programming

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necessary to empower all students.[20] Transforming academia into an environment where gender equity is valued and achieved is essential to enhance its financial viability and ensure its societal relevance in the 21st century.

Research is accumulating on myriad inequities that influence careers of academic women. Women faculty are viewed as less competent,[4] rated lower on teaching evaluations,[5,21,22] comprise less than one-third of recipients of major federal grantees,[6] and are cited less often.[7] Despite a slight rise in female first and coauthorship in recent years, last authorship and associated prestige index is consistently lower for women.[23] Publications with women as first and senior authors are perceived to be of lesser quality than those with male authors.[12] At all faculty levels, women have significantly lower salaries than men.[3,8] These compounding negative differences directly impact retention, promotion, and tenure of academic women.

Despite ample data on barriers to success for academic women, scientific literature contains limited discussion of comprehensive solutions.[24] Our review presented *chutes*—structures that drive women out of academic careers or prevent them from rising to higher levels in academia, and *ladders*—feasible policies and strategies that can be adopted by academic institutions to enable women to stay in academia and reach higher levels of academic achievement (Fig. 1).

Although most of the issues discussed herein may primarily apply to heteronormative binary gender groups (men and women), diverse identities in terms of race, sexual orientation, gender identity or expression, age, disability status, or immigration status do pose unique additional challenges that may go beyond the current review.

Recruitment and Selection

Chutes

Chutes affecting recruitment and selection include environments that promote work hours incompatible with family life, a ''good-old-boys-club'' culture, lack of mentoring, and bias against marriage or having children.[14] Disadvantages also occur during candidate application and review. Compared with recommendation letters for men, those for women tend to be shorter, include more gender references and personal lifestyle details,[25] and refer to skill level and research acumen at half the rate.[26] Even when men's and women's qualifications are equivalent according to objective measures, both men and women search committee members may perceive a woman candidate's qualifications, including peer-reviewed publication quality, to be lower.[12] Further, many women do not apply for academic jobs due to gender or sexual harassment or a lack of working mother role models.[13]

Ladders

Institutional interventions can increase awareness of and commitment to establishing gender equity in hiring.[8] In a 3-year intervention, the University of California Davis implemented a campaign to promote academic culture flexibility and increase awareness of family-friendly policies for faculty such as family and medical leave, tenure clock extension, and part-time appointment options.[8] Women faculty reported a culture shift of increased work/life flexibility acceptance, decreased use of biased language in recommen-

dation letters, and gender balance of assistant professor hires.[8] A second initiative implemented at the University of California Irvine to increase women's presence and advancement increased the percentage of new women hired and women faculty overall compared with other University of California campuses during that time.[27] The intervention included an equity advisor system, workshops, lecture series, gender equity awards, and dependent care travel awards. Thus, evidence-based policies that can increase the percentage of women recruited and selected for academic positions[14] include the following:

- **Equity advisors:** Respected senior faculty committed to equity should be appointed as equity advisors and given protected time to improve and monitor equity efforts. Equity advisors can be directly involved in hiring, advancement, pay equity, cultural issues, and award nominations. They can also review job listings and interview questions for biased language, provide workshops to support faculty and trainees, and report to leadership on practices that help or hinder the equity mission.[27]
- **Job advertisements:** State prominently that candidates from diverse sex, racial/ethnic backgrounds, creed, religion, age, disability, sexual orientation, gender identity and expression, marital status, national origin, political opinions or affiliations will be interviewed, using strong language to emphasize institutional commitment to diversity and inclusivity.
- **Search committees:**
  o Use rubrics to standardize applicant evaluations,[24] and ensure applications are reviewed by two or more search committee members. If significant divergence arises, it should be discussed at a full committee meeting.
  o Request that writers of recommendation letters consider their potential biases when formulating letters. A gender bias calculator should be used (Table 1).[28]
  o Consider both raw- and gender-adjusted publication metrics to account for women-first authors being cited less.[29]
  o Script portions of the interview using predetermined interview questions to ensure a level playing field for all candidates. Create a rubric to score candidate's responses to each question.
  o Request departments to participate in a gender bias habit-changing intervention. In a cluster-randomized controlled trial at University of Wisconsin-Madison, experimental departments received a gender bias habit-changing 2.5-hour intervention workshop. The proportion of women hired by departments exposed to the intervention increased by 18 percentage points.[30]
  o University of Connecticut's Office of Institutional Equity provides an example of institutional policies that enhance gender equity in faculty recruitment (Table 1).
- **Interviews:** In invitations for in-person interviews, candidates should be offered family-friendly accommodations to emphasize institutional commitment to hiring women.

FIG. 1. A roadmap for equity in academia. Color images are available online.

Table 1. List of Resources to Support Institutional Efforts That Support Women Faculty Recruitment, Retention, and Career Success

Recommended action	Real-Life example of recommended action
Ladders to support women in academia	
1. Enhancing recruitment and selection of women faculty	
Evaluate gender bias in letters of recommendation for applicants	An online calculator can be used to evaluate gender bias in letters of recommendation: https://www.tomforth.co.uk/genderbias
Encourage faculty and staff to evaluate their own implicit biases	Faculty can be encouraged to take the implicit association test: https://implicit.harvard.edu/implicit
Establish institutional policies regarding search committee formation that enhance gender equity in faculty recruitment	University of Connecticut's Office of Institutional Equity provides an example of such policies: https://equity.uconn.edu/search-process/search-committee-guidelines
2. Improving family leave policies	
Devise a competitive and fair paid family leave policy	Case Western University provides paid leave for 6–9 weeks for faculty parents: https://case.edu/hr/university-policies/staff-handbook/time-away-from-cwru/paid-parental-leave
3. Minimizing the "Child Tax"	
Develop a childcare and family resources page to support faculty families	University of Pennsylvania's Childcare Resources offers information about a range of family resources and activities: http://www.familycenter.upenn.edu/about.php
Hire a family resources officer who helps faculty parents identify ways to reduce work–family conflicts	Arizona State University offers faculty consultations with a childcare services coordinator: https://eoss.asu.edu/students-families/offcampus
Provide resources to support backup and emergency care	Brown University offers backup care for family emergencies: https://www.brown.edu/about/administration/human-resources/benefits/family-resources/back-care
Offer childcare for snow days and public school holidays that may conflict with university/college schedule	University of Pennsylvania offers "Snow Day Child Care" to support faculty productivity: https://www.hr.upenn.edu/PennHR/wellness-worklife/family-care/snow-day-child-care
Subsidize the costs incurred by needing to travel with children for work	University of Chicago offers Travel Grants of up to $500 per year for faculty needing to travel with their children for conferences and other forms of work-related travel: https://provost.uchicago.edu/procedures/dependent-care-professional-travel-grant-program
	A similar program is offered by Brown University: https://www.brown.edu/about/administration/dean-of-faculty/dependent-care-travel-fund
Increase access to summer camps on or near campus	University of Houston offers summer campus for a variety of ages and focused on a variety of topics: http://www.uh.edu/about/community/summer-camps
Create institutional partnerships with online resources that increase access to child, pet, and family care needs	Many universities now subsidize faculty access to Care.com, including:
	University of Florida: https://www.care.com/edu/university-of-florida
	Harvard University: https://www.care.com/edu/harvard-university
	Rice University: https://www.care.com/babysitters/rice-university
4. Providing lactation support	
Distribute adequate lactation facilities throughout campus	University of Pittsburg provides a map of lactation rooms and details about their accommodations: https://www.diversity.pitt.edu/resources/lactation-rooms
5. Mentoring women faculty across career stage	
Develop mentoring guidelines designed to develop and sustain the career success of all faculty	Columbia University has produced a *Guide to Best Practices in Faculty Mentoring* to improve faculty mentoring, university wide: https://provost.columbia.edu/sites/default/files/content/MentoringBestPractices.pdf

(continued)

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TABLE 1. (CONTINUED)

Recommended action	Real-Life example of recommended action
Recognize faculty members who are excellent mentors of junior faculty through dedicated awards	University of Nevada Medical Center has established an ''Inspirational Mentor of Educators'' award: https://www.unmc.edu/academicaffairs/faculty/awards/index.html
Increase access to leadership and career development workshops and opportunities	Case Western University has created an institute dedicated to developing women faculty leadership skills: https://case.edu/centerforwomen/programs/women-faculty-leadership-development-institute
Provide support to attend leadership development seminars	Duke Medical School supports registration and travel costs for women faculty to attend the Leadership Development Seminar: https://medschool.duke.edu/about-us/news-and-communications/med-school-blog/applications-are-open-2019-early-career-women-faculty-leadership-development-seminar
Create a gender equity Council to ensure salaries, promotion opportunities, and endowments are distributed equitably among male and women faculty	University of Texas has created a council dedicated to overseeing gender equity in faculty salaries, promotion, and endowments: https://provost.utexas.edu/faculty-affairs/gender-equity-council
Offer networking and support for career advancement of women faculty	University of Alabama Birmingham chapter of the American Medical Women's Association (AMWA) and University of Florida Association for Academic Women (AAW) are examples of this as the AMWA promotes the accomplishments and success of women physicians and the AAW provides consistent networking and career advancement opportunities for all women faculty. https://www.uab.edu/medicine/diversity/initiatives/women/amwa https://sites.google.com/site/academicwomenufl

- **Start-up and compensation:** Departments should monitor start-up packages and compensation for equity and Deans in schools and colleges should hold departments accountable to do so. Posting this information publicly by gender is recommended for full transparency. Departmental statistics on gender equity in compensation should be provided to interviewees.
- **Review progress:** Collect data on faculty recruitment to recognize and reward departments achieving gender equity in interviewing, hiring, and salary compensation, benefits, and start-up resources. Guidance should be provided to departments not achieving gender equity.[24]

Career Development and Retention

When postdoctoral women consistently experience gender bias, they are less likely to remain in academia or at a specific institution,[31] which represents significant loss of time and resource investment for the institution and can also be a loss of talent. Of 24 medical schools studied, 40% had no special program for recruiting, promoting, or retaining women faculty and considered such programs unnecessary.[32] While it may be concluded that female trainees who leave academics do so by choice, the drivers of this choice are typically related to inhospitable environments (*e.g.*, gender or sexual harassment, insufficient mentorship, hours incompatible with parenting).

Mentoring

Chutes

Lack of mentoring has been identified as an obstacle to career and personal development among women.[33] In med-

icine, for instance, more women than men report difficulty in finding same-gender mentors[34–36] due to fewer senior academic women[37,38] and lack of effective mentoring programs.[37,39] While possibly becoming more limited in response to the #MeToo movement,[40] male mentors give priority to technical issues and are less likely to sufficiently address career concerns that disproportionately affect women, such as discrimination or harassment, implicit/explicit bias, and work/life balance.[37] Academic institutions should review mentoring programs to assure all faculty have high-quality mentorship and to identify and remedy deficiencies.

Ladders

Faculty with effective mentoring report greater confidence, career satisfaction, productivity, and self-efficacy in teaching, research, and clinical skills.[34,36,38,41–44]

- **Mentor training:** To improve effectiveness of mentoring, prevent abuses, and promote mentorship excellence, all faculty should be provided mentorship training.
- **Women role models:** Departments with a limited number of women should bring in successful academic women as speakers, and arrange meetings with women faculty and students about academic career benefits.
- **Multiple-mentor networks:** Formal mentoring programs[45] can be implemented to build relationships based on career level, expertise, and other factors.[37,46] Midcareer is often neglected but is a time when women faculty often juggle burgeoning responsibilities at work and home, and re-evaluate professional goals. Networks can ensure faculty receive advice on career

choices, work/life balance, and institutional politics.[37] Ensuring faculty create mentor networks may decrease the inherent power imbalance within a junior–senior dyad and can encourage collaboration with colleagues at other institutions.[47]

- **Peer mentoring:** New faculty should be assigned a peer mentor, and guidance for peer mentors should be provided as a complement to senior mentor/junior mentee relationships, which can be limited by generational and gender differences.[47]
- **Reward excellent mentors:** Mentoring is a significant investment of time and energy; recognition and compensation provide motivation and add to satisfaction from helping others. Such accolades may also increase institutional reputation due to enhanced faculty success and faculty recruitment.[48] For example, University of Nevada Medical Center established the "Inspirational Mentor of Educators" award (Table 1).
- **Professional event organization:** Academics involved in organizing local, national, or international conferences and workshops should assure gender balance in plenary speakers, and arrange mentoring and networking opportunities with academic women. Also, family-friendly policies at conferences should be implemented and advertised.

Teaching Evaluations

Chutes

Teaching evaluations are often biased against women professors[5,21,22] and for this reason, using student evaluations to judge faculty competency may violate Title IX policies.[49] For example, when online instructors of both genders with identical course content were presented to students, men were consistently rated higher.[21] In one study, teaching evaluations for men focused on qualifications and course content, while evaluations of women focused on physical appearance and personality.[49] Women are also less likely to be described with words such as "brilliant" or "genius."[50] Further, students were more likely to refer to men as "professor" and women as "teacher."[49] Students attempting to negotiate grades were more aggressive with women than with men and, when negotiations with women professors were unsuccessful, complained more on evaluations.[49] Not all studies, however, found that teaching evaluations differ between men and women. A primary factor influencing positive student evaluations on RateMyProfessor.com was perceived physical attractiveness of the instructor, regardless of gender.[51] In response to pressure, RateMyProfessor.com removed its rating system on attractiveness of professors.

Ladders

- **Correct for bias:** Analyze evaluation data to determine whether women systematically receive lower scores. Both raw- and gender-corrected scores should be used for faculty progress reports and tenure/promotion packets.[5]
- **Implement peer/third-party evaluations:** Department chairs can add faculty peers and/or third-party evaluators with appropriate implicit bias training to conduct teaching evaluations and can develop rubrics to standardize evaluations.

- **Other metrics of teaching acumen:** Introduce other means of evaluating teaching such as peer observation with feedback and attendance at pedagogy workshops and conferences.

Academic Service

Chutes

Women faculty engage in a disproportionate amount of service.[52] National survey data from >140 institutions found that women spend 31.2 more hours per year in service (controlling for rank, race, discipline) than men.[52] This difference is greater for associate professors: women spent 27% of their time on service while men spent 20%.[53] This difference is driven by internal service (*e.g.*, departmental committees) rather than more prestigious external service (*e.g.*, professional societies).[52,53] Service to professional societies can increase prominence, whereas intramural service rarely does. Differences may result from women being asked more often than men to serve and/or being less likely than men to decline requests.[52] Service, teaching, and research are considered the three pillars of academia; however, research and teaching lead to greater prestige and promotion potential.[53] Promotion and tenure committees may recognize service, but not consider it critical.[54]

Ladders

- **Service allocation:** Department chairs should audit service assignments and redistribute as needed to ensure fairness. If there are fewer women faculty than men, women should be assigned to higher stakes committees where diversity is lacking or particularly important, such as tenure/promotion committees.
- **Service load:** Service assignments, including time commitment, should be quantified and included in annual evaluations and tenure/promotion materials to ensure service distribution is equitable.[52] For example, weekly hours required for an assignment could be calculated, or assignments given a workload rating. Institutions could have minimum service requirements for all faculty as a condition for promotion.[53]
- **Compensation:** For service that engenders high workload, such as being on an IRB committee, compensation and dedicated time should be provided.[53]
- **Reward excellence in service:** Recognition and rewards for faculty service highlight its value. University of California Berkeley has a Berkeley Faculty Service Award to honor faculty members for their service (Table 1).

Family Issues

Junior women faculty often enter academia during childbearing age, and milestones, including marriage and childbirth, account for the largest loss of women academics between the time a PhD is earned and tenure acquired, which is not the case for men.[14] A survey of >4,000 faculty members at 507 academic institutions found that, before tenure, significantly more women than men decide to stay single, delay having a family, and have fewer children.[55] Moreover, one study on science, technology, engineering, and mathematics

(STEM) faculty documented that, after having a first child, 43% of women compared with 23% of men leave full-time STEM employment, and the rates are significantly higher than faculty without children (Fig. 2).[13] Of those in the sciences who are married and have children, women are 35% less likely to obtain a tenure-track position than men[14]; of those in tenure-track positions, women are 27% less likely to achieve tenure than men.[14] When surveyed about decisions to continue in research, twice as many women as men (44% vs. 20%) cite childcare and parenting as a critical decision factor.[56,57] Although these differences may reflect preferences for some women, it is impossible to ignore how the gender disparity in domestic workload and the higher proportion of male faculty (20% vs. 5%) who have spouses who are not in the workforce affect women's preferences.[58] Policies that support all faculty in balancing career and family may have particularly large and positive effects in retaining women in academia.

It is important to note that some gender-neutral policies have led to unintended consequences, including advancing the careers of academic men often at the expense of academic women. For example, gender-neutral policies to grant tenure extensions after childbirth or adoption led to a 19% rise in the probability that a male economist would earn tenure at his first job, while women's chances of gaining tenure fell by 22%.[59] Given that before the arrival of tenure extension, <30% of all faculty in economics gained tenure at their first job, the magnitude of this decline for women is especially alarming.[59] The broader issue herein is that an employment policy that is gender neutral on paper may not be gender neutral in practice. In the case of tenure extension, women receive this parental benefit typically coinciding with the challenges of pregnancy, childbirth, recovery, and breastfeeding, while men do not directly experience these physical aspects, but receive the same or similar benefits at some institutions. Thus, it is essential to continue to evaluate gender-neutral policies and challenge the assumptions that they benefit all equally, and to proactively modify policies to achieve desired outcomes for all faculty.

Leave Policies

Chutes

In the United States, the Family and Medical Leave Act (FMLA) provides employees with unpaid job protection for 12 weeks over 12 months, and some academic institutions offer paid family leave for specific reasons, including birth or adoption of a child. Pretenure women, however, often return to work sooner than required after childbirth.[55] This trend may be harmful as a study evaluating the association between duration of maternity leave and birth outcomes in countries across the world found that mean maternity leave duration was 15.4 weeks, and that each additional week of maternity leave decreased preterm birth rates by 0.09% and 0.14% lower rate of low birthweight.[60] Women are also more likely than men to leave the workforce during peak productivity years to care for aging parents.[61] To the extent that society places a higher burden on women for child and eldercare, workplaces must accommodate.

Ladders

Parental leave, especially paid family leave, improves health outcomes for both children and mothers,[62–64] in part by extending the duration of breastfeeding,[65] and increases the likelihood that women return to work.[66] Similar benefits likely
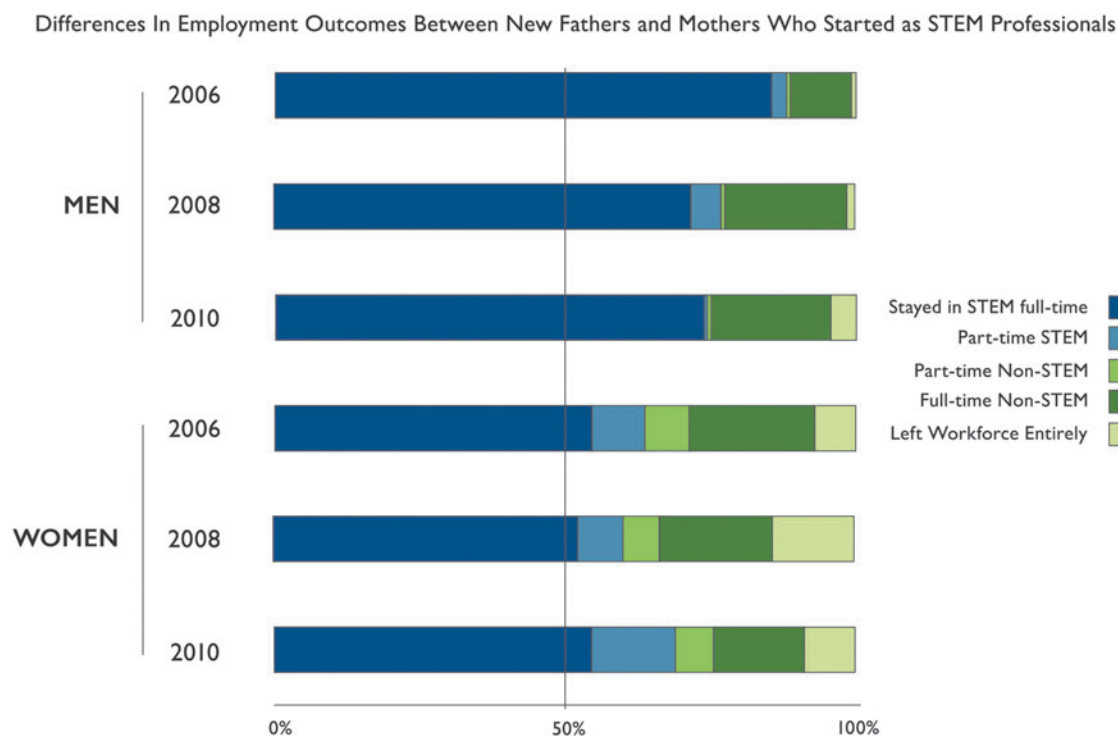
FIG. 2. Employment outcomes of men and women who started as science, technology, engineering, and mathematics (STEM) professionals employed full-time in 2003 and then had their first child between 2003 and 2006 and did not have another child between 2006 and 2010 (N = 532). Redrawn with permission from Cech and Blair-Loy.[13] Color images are available online.

result with paid leave for other family or medical reasons, including care of older and/or ill family members. The optimal duration of paid, job-protected leave has not been established, but a 2017 report by the International Labor Organization of the United Nations recommended 14 weeks.[67]

- **Policy development**
  - Consistent with calls to consider paid family leave a public health priority,[68] institutions should implement competitive and fair paid family leave policies and ensure policies, procedures, and expectations are understood by faculty and staff. A longitudinal Census report found that between 1961 and 2008, women who received paid leave had a greater odds of returning to work within 3–5 months after the birth of their first child, compared with women who did not receive or use paid leave.[69]
  - Institutions should build in flexibility FMLA timing or paid family leave (*e.g.*, before/after childbirth or adoption) and allow extensions in extenuating circumstances.
- **Family Resource Officer:** This position acquaints new faculty with family-related resources, provides information and counseling on FMLA and paid family leave policies, and helps foster family-friendly resources on campus.
- **Family-friendly culture:** Departments should foster a culture in which faculty are encouraged to use leave as needed and identify strategies to prevent stigma related to use of leave for family purposes.
- **Faculty productivity during leave:** Institutions should recommend faculty work with their mentor network, department chair, Family Resource Officer, and other key personnel to develop personalized strategies for sustaining academic activities that may need to continue uninterrupted during leave, such as funded projects and student mentoring.

Domestic Workload and Work-Related Travel

Chutes

Work/life balance is more difficult for women given the disproportionate domestic workload they bear. Data from the American Time Use Survey revealed that women spend 113 minutes on housework daily and men spend 43 minutes.[70] In addition, with heterosexual couples, men's careers get priority. Stanford's Clayman Institute for Gender Research asked academics with an academic partner which career was primary. Of the men, 50% said theirs, 45% said both, and 5% said the partner's[57]; of the women, only 20% said theirs, 59% said both, and 21% said the partner's. Among academics who earn more than their partner, this disparity persisted: 61% of men considered their career as primary but only 44% of women did.

Among academics with children, data suggest that women take on more childcare responsibilities than men, and congruently, women with young children are 28% less likely to get tenure-track positions than women without children.[71] When combining unrelenting time pressures of academia with caregiving hours and housework, women faculty with children average >100 hours of combined activities per week compared with 86 hours for men with children.[72] This has been referred to in scientific literature and mainstream media as the ''child tax'' women pay in professional settings. Not

surprisingly, among men and women tenure-track professors (n = 184), fewer than 36% of women and 44% of men viewed tenure-track careers as family–friendly.[71] In a 2018 qualitative study, physicians who became mothers described diverse maternal discrimination experiences including lack of support during pregnancy and postpartum, limited advancement opportunities, and financial inequalities, including lower pay than equally qualified colleagues.[73] In STEM fields, in 2010, after women had their first child, 10.6% transitioned to a part-time STEM position, 5.6% to a part-time non-STEM position, 12.1% to a full-time non-STEM position, and 14.8% left the workforce entirely (Fig. 2).[13] Childcare responsibilities not only affect the time women faculty spend at work but also constrain time for conferences and work-related travel, which prevents them from attaining the productivity and collaborative opportunities needed to achieve recognition and career success. Essentially, society places a higher burden on women for childcare and domestic labor, and then punishes them in the workplace for bearing that burden. This implicitly sends a message to women in the workplace that they do not belong, putting a responsibility on leadership to counter that message regardless of whether they feel they explicitly reinforce the message.

Ladders

Access to childcare and reimbursement for work-related childcare expenses can improve faculty productivity,[74] particularly women,[75] as follows:

- **Day-to-day childcare:** Employer-based childcare has shown promise in improving recruitment and decreasing employee absence, cost of lost work time, and employee turnover,[76,77] although long wait lists due to insufficient capacity is an issue on many campuses. Therefore, institutions should expand capacity and hours of on- or near-campus childcare. Guaranteed, immediately available childcare spots once paid leave ends is recommended.
- **Backup/emergency care:** Institutions should partner with backup/emergency care, after-school care, and summer programs to offer faculty support for childcare needs.
- **Family care memberships:** Access to qualified family care should be included in faculty benefits packages (*e.g.*, Care.com, Sittercity). Such services can enable faculty travel for work and benefit all faculty.
- **Work-related travel:** Faculty should be reimbursed for childcare expenses incurred at work-related travel, whether through external funds such as National Institutes of Health (NIH) funds that allow childcare as a reimbursable expense[78] or internal funds allotted for academic family support such as Brown University's Dependent Care Travel Fund (Table 1). Institutions may need to advocate for policy change at the state level.
- **Teaching schedules:** As part of course scheduling, faculty should be polled regarding times available for courses to provide flexibility for balancing work and family.
- **Educate faculty about family-friendly policies:** Institutions should increase faculty awareness of family–friendly policies as University of California Davis (UCD) has done, creating a family-friendly work culture.[8]

Breastfeeding

Chutes

While 75% of women choose to breastfeed after delivery, only 40% continue breastfeeding after returning to work.[79] When women return to work, they use pumps to express milk and refrigerators/coolers to store it. This must be done two to three times during an 8-hour workday and takes ∼15 minutes each time.[80] It cannot be done in bathrooms that lack electrical outlets, appropriate seating, and privacy.

Ladders

Breastfeeding benefits both mothers and babies, and lowers health care costs.[79,81] At companies with policies to support breastfeeding, women are more likely to continue breastfeeding for ∼6 months.[79] Implementing lactation support can have a positive impact on institutions by decreasing sick leave use by mothers,[82] lowering turnover rates,[83] increasing productivity,[84] and improving morale and job satisfaction. Lactation policies are already in place at some institutions: for example, the NIH has a Nursing Mothers Program with lactation room guidelines and locations.[85] The University of Florida has six breastfeeding pods around campus and nursing rooms in many buildings. Further, companies such as IBM have policies to pay for breastmilk to be shipped home when mothers are required to be away from their child for work travel.[86] A breastfeeding support structure creates equal opportunities for women academics to remain in the workforce[87] as described in the following recommendations:

- **Provide lactation rooms with pumps:** Private spaces should be provided throughout campus for breastfeeding and pumping that are ∼4′×5′ and include a hospital-grade breast pump, electrical outlet, a small refrigerator, a sink, and a suitable chair.
- **Travel support:** Institutions should cover costs of shipping breastmilk home while mothers are on work-related travel.
- **Childcare reimbursement:** Childcare costs of traveling with children should be reimbursable when done for work-related travel.

Work-Related Events

Chutes

Women report significantly more dissatisfaction related to work/life balance than men,[41] as reflected in antiquated academic norms established when faculty were men whose spouses were homemakers. For example, many career development activities, such as networking and special events, occur outside the typical workday when childcare options are limited or costly. Because they shoulder more childcare responsibilities than men,[71,75] academic women with children are more likely to miss these events and may be perceived as less invested in their career, department, institution, or field.

Ladder

- **Scheduling:** Academic events, including meetings and networking events, should be scheduled during the standard workday, when possible. Events occurring outside the typical workday should include family participation or provision of childcare, including reimbursement.

Productivity and Advancement

Significantly more male assistant professors receive tenure/promotion and are trained for administrative leadership than their female counterparts.[15] This trend applies to other leadership positions as well: In 2012, the proportion of women in high-ranking administrative positions was 12%[88]; in 2018, of 58 NIH Clinical Translational Science Institutes, only 17.2% were led by women[89]; and in early 2019, only 16% of National Academy of Science members were women.[90]

Chutes

Research funding and productivity are crucial to sustaining academic careers in STEMM and, during early- to midcareer, often present challenges for women. Start-up support funds can influence funding success and have been associated with early-career attrition rates.[91] However, one study found that tenure-eligible females receive less start-up funds than their male counterparts.[92] While this could be dismissed as due to poor negotiation skills among women, research shows that women who negotiate are penalized such that colleagues feel less inclined to want to work with them in the future and their being regarded as too demanding.[93]

Gender disparity also exists for grant funding

For NIH grants awarded from 2006 to 2017, only 43.6% of grants given to first-time primary investigators (PIs) were women, despite no baseline performance measure differences. Across all grants and institutions, median funding was $126,615 for women and $165,721 for men.[94] Moreover, NIH grant renewal rate for women is significantly lower than that for men.[6] Gender bias in NIH reviews is one possible explanation.[95]

Ladders

With institutional support, the number of women faculty tenured and promoted to higher ranks and executive positions will increase. The corporate world has led the way in equity by initiating programs to accelerate career advancement of women.[96] Example sponsorship programs include elements such as the following:

- **Equitable pay:** Faculty pay and start-up packages must be equitable between men and women. Institutional monitoring can identify and correct discrepancies.
- **Set boundaries on negotiation:** To the extent that some candidates receive financial and social benefits from negotiation and others do not, eliminating or reducing the ability of candidates to negotiate would create a fairer playing field. Alternatively, instilling equity raises in faculty with equal merit who received lower salary or start-up offers than others could even the playing field.
- **Training:** Institutions should provide support for training in leadership, coaching, and financial management to help advance women into leadership roles. One study showed that having a woman as department

chair was associated with increased publications, higher likelihood of tenure, and a shrinking pay gap.[97]

- **Networking support:** Institutions should encourage and provide opportunities for all faculty to participate in networking, training, and mentoring programs.
- **Tenure, promotion, and leadership roles:** Institutions should regularly monitor gender breakdown and correct discrepancies.
- **Distinguished ranks:** Institutions should distribute endowed chairs and leadership positions equitably between men and women.

Discussion and Conclusions

Behavior is shaped by unconscious implicit biases based on stereotypes, and academics are not immune to these.[98] Thus, achieving equity and diversity in academia is a complex, but critical and achievable challenge. Women face a gauntlet of chutes out of academia and advancement, which institutions must systematically address through policy changes. This call to action provides specific steps and resources (Table 1) for promoting an academic culture of respect and equal opportunity for all and for cultivating the inclusive learning environments necessary to empower students as future leaders.[20]

The U.S. Equal Employment Opportunity Commission is responsible for enforcing federal laws that make it illegal to discriminate against applicants or employees based on a variety of factors, including one's sex (including pregnancy status, gender identity, and sexual orientation), race/ethnicity, and age, and apply to all types of work situations, including hiring, firing, promotions, harassment, training, wages, and benefits. Thus, there is a regulatory obligation for enacting policies and practices that do not perpetuate sexism and discrimination. Recommendations gleaned from our review to meet these obligations are concrete and actionable. Moreover, the data we present can be used to appeal to state legislators, whose influence over funding allocations can significantly impact an institution's ability to implement some of the recommended changes. More research is needed, however, to identify methods for change when resistance is encountered.

Limitations of this review include a focus on heteronormative binary gender norms primarily within the United States. As noted earlier, people of color and LBGTQ+ individuals experience similar barriers, in even more pronounced ways, and deserve additional discussion.[99] This is a critical issue as non-Hispanic white women and women of color, and those from other marginalized groups, may be influenced differently by the same policies or actions. Thus, we recommend that institutions investigate the effects of new policies, not only by sex but also by race/ethnicity and other relevant subgroups. We also recognize other barriers to success in academia not addressed here, including but not limited to, reproductive health challenges and sexual harassment. As the National Academy of Sciences, Engineering, and Medicine recently noted, sexual harassment of women in academia can lead to women leaving these fields.[100] The report also states that "there is no evidence to suggest that current policies, procedures, and approaches have resulted in significant reduction in sexual harassment," and significant changes need to be made.[100] In addition, the focus of

this review was on the faculty level, thus the majority of the data presented are from the postdoctoral level and above. Components of educational training from primary school, undergraduate and graduate school likely also contribute to the leaky pipeline but were outside of the scope of this review.

Despite ample data on barriers to success women face in academia, data supporting evidence-based solutions are limited beyond that proposed elsewhere.[24] Many solutions require research to evaluate effectiveness and possible unintended consequences, thus we recommend data collection before, during, and after implementation of recommendations. These changes could make academic careers more attractive to women, and contribute to the academic engines of creativity and productivity. This goal can only be achieved by enabling all people—regardless of gender or minority status—to have equitable opportunities for academic success.

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